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Council for Scientific and Industrial Research

Properties of Australian Timbers

Part 1.—Eight Timbers of the Genus *Eucalyptus* (Ash Group)

(Division of Forest Products.—Technical Paper No. 13)

Collated and Edited

by

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FOREWORD.

This publication is the first of a series in which is is proposed to record the available information regarding the properties and uses of the principal commercial timbers of Australia.

The data it contains have been collected from various publications, a list of which is included, and from unpublished reports of the various Sections of the Division of Forest Products. Officers of the Division have personally visited the principal milling centres in all the States and a very large number of the main wood-using industries, in order to study the uses of timbers.

In addition, use has been made of the results of five years' work in the Division, covering numerous phases of utilization, seasoning, preservation, mechanical properties, structure, and chemistry. It is realized that in some respects the information is incomplete, as additional data are constantly being collected. However, it has been deemed essential to begin this series in order to supply a source from which reliable information concerning Australian timbers can be obtained.

Great care has been exercised in checking information supplied from sources outside the Division's own investigations. Information as to quantities available and distribution has been obtained from State Forest Services.

It is realized that where figures as to quantities available are given, these cannot be regarded as definite, for it is not possible to arrive at a close estimate of many eucalypt forests. Some Forest Services have been able to supply estimates of the volume of standing timber, which they realize are at best only to be taken as indicating the order of magnitude of the quantities. They are published to indicate in what quantities it would be possible to order any specific timber. It is hoped to give, in the future, more detailed information as to the quantities of timbers in New South Wales.

Many commercial timbers in Australia occur only in amounts which can supply local markets; others would supply a limited overseas demand; and still others are capable of supplying a large export market.

The figures quoted must only be taken as an indication in this direction, and it is felt that so long as this is clearly stated, there can be no misunderstanding if they are published.

The information has been collected together and put into form for publication by H. E. Dadswell, Senior Wood Anatomist, but all the officers of the Division have taken their part in obtaining the data and in a critical review of the typescript, and it is fitting that a record should be made here of the work of S. A. Clarke (Deputy Chief), W. E. Cohen (Senior Chemist), J. E. Cummins (Senior Preservation Officer), C. S. Elliot (Senior Seasoning Officer), W. L. Greenhill (Seasoning Officer), I. Langlands (Timber Mechanics Officer), R. F. Turnbull (Utilization Officer), and A. J. Thomas (Assistant Seasoning Officer).

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314 Albert-street, East Melbourne,
October, 1933.

The Properties of Australian Timbers.

PART 1.

Eight Timbers of the Genus *Eucalyptus.* (Ash Group.)

1. Introduction.

The group selected for this, the first publication of a series, is the so-called "Ash" group of eucalypts. A number of eucalypts of low density and pale colour have been called "ash" timbers because of a superficial resemblance to the ashes of the Northern Hemisphere (*Fraxinus* spp.). These timbers are of definite commercial importance since they have found favour both in the local trade and in the overseas markets. They have been described at various times (3, 12), but the publications are not of recent date. Therefore, because of their commercial importance and because additional information of practical value to users is available, some repetition is justifiable.

Of the eucalypts, the timbers of the species listed below have, to a varying degree, the general appearance mentioned above. These species are listed in order of commercial importance—

E. regnans F.v.M.

E. gigantea Hook. syn. *E. delegatensis* R.T.B.

E. obliqua L'Her.

E. sieberiana F.v.M.

E. fastigata Deane & Maiden.

In addition, the species *E. oreades, E. fraxinoides,* and *E. consideniana* are also considered.

E. regnans. E. gigantea and *E. obliqua* are of more or less equal importance, and are commonly sold in Australian and overseas markets as Tasmanian or Australian oak.

All the timbers of the above species are pale coloured, light or moderate in weight, of open texture, and generally straight-grained. In cell structure, they are very much alike, and definite identification is not always possible.

2. Description of the Three Important Species.

Eucalyptus regnans F.v.M.

Trade and Vernacular Names.

Recommended.—Mountain ash.

Commonly used.—White ash (Vic.), swamp gum (Tas.), Tasmanian oak, Australian oak.

Rarely used.—Blackbutt, giant gum, white gum.

Because of the confusion of trade names, "regnans" has also come into use recently.

Habit and Distribution. (2, 3, 8, 10, 11, 12.)

This is a large forest tree, reaching in some cases a height of 300 feet or more, in which sizes it becomes one of the largest trees in the world; the trunk is straight with a long clear bole, and the crown is scanty. The bark is of a sub-fibrous type which is dark at the base; higher up the trunk it is ribbony and then smooth and white. *E. regnans* is a very fast growing tree, and in 40 years has given a butt of 2 feet to 2 ft. 6 in. in diameter (9). It occurs abundantly in Eastern Victoria and in Tasmania.

Supplies.*

The assessment of forest areas for this species is incomplete, but the following approximations give an indication of quantities available:—

> *Victoria.*—Estimated standing volume of millable timber in nine major milling districts—approximately 3,000,000,000 super feet in the round.
>
> Average annual cut for these districts during the past five years—approximately 70,000,000 super feet in the round. This figure may be considered conservative in view of the depression in the timber trade.
>
> *Tasmania.*—Forest areas of this species—approximately 100,000 acres.
>
> Total volume of standing timber—1,500,000,000 super feet in the round.
>
> (This figure is probably low, due to lack of assessment figures for certain areas.)
>
> Average annual cut during past five years from both Crown land and private property—approximately 40,000,000 super feet in the round.

In the milling of this species, recovery of sawn timber is about 50 per cent. of the quarter girth log measure. Of the sawn timber obtained, approximately one-third is free from all defects, while the balance contains minor to major defects, chiefly in the form of gum veins and gum pockets.

Many kiln-seasoning plants are established at mills cutting this species exclusively, and thoroughly kiln-dried and reconditioned material is readily available.

General Characteristics of the Wood.

The timber is usually white to pale brown in colour, although sometimes pinkish, for the most part straight grained and of open texture. Growth rings are often distinct, especially in timber from higher altitudes. For the highest grade purposes, the timber is usually specified quarter-sawn, and this class of material has a pleasing, although not a pronounced, figure. Back-sawn material has a more striking figure, but, owing to the frequent occurrence of surface checking during seasoning, it is not a standard product. From butt logs, wavy and curly grained material of great beauty is sometimes obtained, while butts also provide a source of highly figured veneers.

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* See remarks in the Foreword, *re* quantities available.

This timber is one of the most easily worked eucalypts, and being light in weight replaces imported softwoods for many purposes.

Logs show a narrow band of sapwood, rarely over 1" in width. Wood formed during the early years of growth shows much wider growth rings than that laid down in later years. Fire-killed timber when felled as soon as possible after the fire, has been milled up to two years after felling without serious conversion loss or any deterioriation of the truewood*.

Weight.

The seasoned weight at 12 to 15 per cent. moisture content averages 41 lb. per cubic foot, but there is a considerable range depending on the nature of the piece, i.e., whether fast or slow grown, and whether collapsed or not.

The basic density range for the truewood of this timber is 26 to 34 lb. per cubic foot. These results are derived from numerous tests, and are based on the ratio:

$$\frac{\text{Oven-dry weight}}{\text{Volume when soaked to maximum volume.}}$$

The basic density figure is not one that can be easily ascertained by the practical man, but is of great value in comparing timber from the same or different species and in distinguishing between timbers. In this determination, the effects of collapse and moisture content are eliminated.

The green weight averages approximately 60 lb. per cubic foot, and ranges from 55 to 70 lb. per cubic foot.

Moisture Content.

The moisture content of the truewood from mature trees is on an average 100 to 120 per cent. based on the oven dry weight, while that of the wood from young trees may be considerably higher.

Seasoning.

Successful methods for seasoning the timber have been carefully developed and details recently published (7). Collapse is very common, but fortunately the now widely adopted reconditioning treatment† has eliminated a large proportion of the loss that formerly occurred. For reconditioned material, the shrinkage when dried from green to 12 per cent. moisture content is to 4 to 5 per cent. radially and 7 to 10 per cent. tangentially (7).

Durability and Adaptability to Preservative Treatment.

The timber of this species is not used where it is in contact with the ground or where it is subjected to termite (white ant) attack.

The truewood can be impregnated with water-soluble preservatives under pressure, but with oil preservatives under the same conditions treatment is more difficult (13). Available data indicate that open tank

* The term "truewood" has been adopted to describe what is usually termed heartwood. In Australia, the central portion of a tree is very often affected by decay or has little strength. This portion, which is really part of the heartwood, is called "heart." The terms "heart" and "heartwood," are, therefore, confusing, and that portion of the tree between the "heart" or the pith and the sapwood has been named the truewood.

† Originally developed by Messrs. Grant Bros. of Warburton, Victoria.

treatments are not generally satisfactory. Sapwood of posts, poles, &c., can be readily treated even by the open tank process so that this class of material can be made very durable.

Uses.

Main Uses.	Secondary Uses.	Possible Uses.
Flooring. Weatherboards. Lining. Joinery and interior trim. Furniture and cabinet work Carriage, tram, and motor bodies. General house and building construction.	Railway trucks (end and quarter boards). Cooperage — staves chiefly for glucose and tallow casks. Veneers. Case timber. Wood wool. Palings.	Handles— Light hammer. Shovel. Broom. Rake. Cross arms. Baseball bats. Paper pulp— Chemical. Groundwood.

One of the most important uses of this timber is in flooring, in which capacity an excellent reputation has been established, both locally and abroad.

Chemical Composition.

Results have been published for thirteen different samples of this species (6). The following table indicates the average chemical composition of the timber (all percentages based on oven-dry wood) :—

Constituent.	Average.	Range.
	%	%
Cellulose (Cross and Bevan)	50	56–44
Lignin, determined according to standard methods adopted by the Division of Forest Products ..	20	18–24
Material soluble in N/8 sodium hydroxide solution ..	20	13–30
Hot water soluble material	10	5–15
Ash	Approximately 0.1	..

This species has been used experimentally in the production of a good grade of sulphite pulp (5), and suitable groundwood has also been obtained (4). Present proposals for the manufacture of newsprint in Australia are based on the excellent experimental results obtained.

Wood Structure.

Macroscopic and microscopic examination of 14 different samples gave the following results:—

Burning splinter test.—Match size splinters burn to a charcoal plus small amounts of grey or black ash.

Pores.—Large, not numerous, numbering from 70 to 140 per area of 20 sq. mm., single and generally open.

Vessel lines.—Conspicuous on longitudinal faces.

Vessel contents.—Tyloses present but not strongly developed —it is often possible to blow through a length of several feet.

Parenchyma.—Not visible under lens.

Rays.—Very fine, not visible on cross section except with lens, distinct on radial surfaces.

Minute anatomy.—*Rays,* more or less heterogeneous, mostly uniseriate, few biseriate and then only in one or two cells; numbering 46 to 70 per sq. mm.; maximum number of cells high varies from 15 to 20, average number of cells high 7 to 11; cells contain little extraneous matter; *parenchyma,* not abundant, paratracheal in position.

Remarks.—This timber is in some cases not distinguishable from *E. obliqua* or *E. gigantea.* In general, however, *E. gigantea* shows more distinct growth rings with fewer pores in the late wood, while in *E. obliqua* biseriate rays with large cells are more numerous.

Illustrations.—See Plates 1 and 2.

Eucalyptus gigantea Hook syn. ***E. delegatensis*** R.T.B.

Trade and Vernacular Names.

Recommended.—Alpine ash.

Commonly used.—Red mountain ash (Vic.), red ash (Vic.), woollybutt (Vic.), mountain ash (N.S.W.), gumtop stringybark (Tas.), white top stringybark (Tas.), Tasmanian oak.

Rarely used.—Messmate.

Habit and Distribution (1, 2, 3, 8, 10, 11, 12).

The tree has a tall clean tapering trunk, the bark on the lower part being very thick and woolly, and somewhat like that of a stringybark. This type of bark ceases abruptly about halfway up the stem, after which the bark is clean, very thin, and light bluish grey to white in colour. The old bark peels in long strips, and does not generally hang as loosely about the trunk and branches as in the case of *E. regnans.* The tree attains a height of 200 to 300 feet on the slope of the main divide in Victoria, and a butt diameter of 2 feet and over is reached in 40 to 50 years. Growth is rapid during the first 12 to 15 years.

The species occurs on the southern tablelands of New South Wales at high elevations up to 5,000 feet, at elevations from 3,000 to 4,500 feet in Eastern Victoria, and at high elevations in Tasmania.

*Supplies**.

Assessment figures are incomplete for this species, but the following approximations give an indication of the quantities available:—

Victoria.—Amount of millable timber in assessed areas—approximately 1,300,000,000 super feet, in the round.

Approximate amount of material in other large areas in which assessment is incomplete—500,000,000 super feet in the round.

* See Foreword.

Average annual cut during past five years—approximately 7,000,000 super feet in the round.

Tasmania.—Standing volume—approximately 1,500,000,000 super feet in the round.

Average annual cut during past five years from both Crown lands and private property—12,000,000 super feet in the round.

In New South Wales, there are large stands of this timber, and it is being milled there. The quantities are not so great as in Victoria and Tasmania.

Recovery during milling is generally 50 per cent. of the quarter girth log measure, and of this material approximately one-third can be classed as clear grade.

Seasoned and reconditioned material can always be readily obtained.

General Characteristics of the Wood.

The timber is usually pale brown in colour, but at times shows a definite pinkish tint which has given rise to the vernacular name "red ash." It is open in texture, usually straight grained, sometimes with wavy grain giving rise to a fiddleback figure in quarter-sawn boards. In the majority of samples, growth rings are prominent, the late wood being darker in colour and denser than the early wood. Pores are numerous in the early wood and occasionally absent from the late wood, and this timber is, therefore, the nearest approach of the eucalypts to ring porosity. The timber is easily worked, and it possesses a pleasing figure owing to the prominent growth rings when either quarter-sawn or back-sawn. Sapwood is not pronounced, being up to 1½″ in width.

Weight.

The seasoned weight at 12 to 15 per cent. moisture content varies from 40 to 50 lb. per cubic foot; weight green varies from 60 to 70 lb. per cubic foot. The basic density range is 28 to 38 lb. per cubic foot, average 33 lb. per cubic foot.

Moisture Content.

The moisture content of green truewood has been observed as high as 110 per cent. based on the oven-dry weight.

Seasoning.

The behaviour of this timber during drying is much the same as that of *E. regnans,* though it is probable that it will take somewhat longer to dry under the same schedule (7). In many instances it collapses considerably, but this can be removed by the reconditioning process.

Durability and Adaptability to Preservative Treatment.

Like *E. regnans,* this timber is not recommended for use in contact with the ground or in locations where it will be subjected to termite attack.

The pressure treatment of the truewood with oil preservatives is difficult, but with water soluble preservatives good penetration and absorption is obtained (13). Sapwood is relatively easy to penetrate.

Uses.

Main Uses.	Secondary Uses.	Possible Uses.
Flooring. Weatherboards. Lining. Furniture and cabinet work. Building construction. Motor car bodies. General joinery.	Vehicles — shafts, felloes, spokes. Internal fittings. Sporting goods— Cricket stumps. Skis. Oars. Aeroplane construction.	Handles— Light axe. Hammer. Pick. Shovel. Rake. Broom. Sporting goods — baseball bats. Tight cooperage — wine casks. Case timber. Cross arms. Wood wool. Clothes pegs. Paper pulp—chemical.

It is recognized as a fairly good bending timber.

Chemical Composition.

The following results have been obtained from the examination of six samples (6). Percentages are based on oven-dry wood.

Constituent	Average.	Range.
	%	%
Cellulose (Cross and Bevan)	57	51–59
Lignin, according to standard methods adopted by the Division of Forest Products	20	18–22
Material soluble in N/8 sodium hydroxide solution ..	17	15–22
Hot water soluble material	4	2–6
Ash	Approximately 0.1	..

This wood has been used in experiments for the manufacture of newsprint in the form of sulphite pulp (5) of which a good quality was obtained, although not quite as good as that from *E. regnans* and *E. obliqua*. In grinding tests for the manufacture of groundwood pulp, the species was not as satisfactory as *E. regnans* (4).

Wood Structure.

Macroscopic and microscopic examination of 13 different samples gave the following results:—

Burning splinter test.—Match size splinters burn to a charcoal tipped with grey or black ash.

Pores.—Show a definite tendency to ring porosity, being larger and more numerous in the early wood; large to medium

in size, numbering from 70 to 160 per area of 20 sq. mm., but generally less than 125; single, but sometimes appearing under lens in short oblique rows.

Vessel lines.—Conspicuous on longitudinal faces.

Vessel contents.—Tyloses usually present. Vessels free from extraneous materials.

Rays.—Very fine, not visible on cross section except with lens, easily distinguishable on radial surfaces, being somewhat darker in colour than surrounding tissue.

Minute anatomy.—*Rays,* more or less heterogeneous (numbering from 55 to 90 per sq. mm., but in only two samples above 65), mainly uniseriate, very few (up to 11 per cent. in some cases) biseriate; maximum number of cells high—15 to 21; average 7 to 9; some extraneous material present in the cells but mostly in less than 20 per cent.; *parenchyma,* not abundant or scarcely any, difficult to distinguish.

Remarks.—This timber is often confused with that of *E. regnans* and *E. obliqua.* Generally, however, it may be distinguished because of the greater tendency to ring porosity and the more distinct growth rings. On the whole, it is lighter in weight than *E. obliqua* and possesses a much smaller percentage of biseriate rays.

In New South Wales, it may be confused with *E. dalrympleana* on outward appearance, but an examination of structure shows that *E. dalrympleana* has a large percentage of biseriate and triseriate rays.

Illustrations.—See Plates 3 and 4.

Eucalyptus obliqua L'Her.

Trade and Vernacular Names.

Recommended.—Brown top.

Commonly used.—Brown-top stringybark (Tas.), stringybark (Tas., N.S.W., S.A.), messmate (Vic.), Tasmanian oak, messmate stringybark.

Rarely used.—Woollybutt.

Habit and Distribution.—(1, 2, 3, 8, 10, 11, 12).

This is often a large forest tree attaining a height of 250 feet and a butt diameter of 10 to 12 feet in some localities. It possesses a stringy bark which extends right out to the branchlets. The bark of the trunk is thick and fibrous.

It is found in Victoria, in Tasmania, in New South Wales, and also to some extent in South Australia. In Tasmania, it grows on large tracts of poor hilly country, it is widely distributed, and it is specially well developed in the south; in New South Wales, it occurs on the moist mountains of the eastern side of the southern tableland and on the eastern edge of the northern tableland to near the Queensland border; its distribution is fairly general in the highlands of Victoria.

*Supplies.**

Tasmania.—Estimated standing volume (conservative), 1,500,000,000 super. feet in the round.

Average annual cut for past five years from both Crown lands and private property—*approximately 20,000,000* super. feet, in the round.

Victoria.—Estimated standing volume for nine milling districts—102,000,000 super. feet in the round.

(This estimate does not cover large areas in which assessment is not complete.)

Average annual cut for past five years—3,500,000 super. feet, in the round.

The exact quantities in New South Wales and South Australia are not available, but in South Australia, at least, supplies are very limited.

The average recovery in milling is about 50 per cent. of the quarter girth log measure. In Tasmania, approximately one-third of the sawn timber produced consists of clear material. Victorian logs carry much more gum than the Tasmanian, and the percentage of clear grades is very small.

General Characteristics of the Wood.

The timber is generally pale brown to brown in colour, although some samples show a distinct reddish tinge. It is of open texture, usually straight grained although sometimes interlocked, and moderately heavy to moderately light in weight. Growth rings are fairly well defined, but there is no tendency to ring porosity. Gum veins are common in the timber from the mainland. In the log, sapwood is pale in colour in comparison with the truewood and is generally 1 to 1½" in width.

Weight.

The wood is generally heavier than that of *E. regnans* and sometimes heavier than that of *E. gigantea*. The weight when seasoned to 12 to 15 per cent. moisture content varies from 46 to 56 lb. per cubic foot. Weight green varies from 65 to 75 lb. per cubic foot, while the basic density range is 32 to 44 lb. per cubic foot. In these basic density determinations, some 35 samples have been tested, the majority of which fall within the range of 35 to 41 lb. per cubic foot. Using basic density figures as a basis for comparison, it will be seen that in most cases this species falls outside the range of *E. regnans* while there is some overlapping in the case of *E. gigantea*.

Moisture content.

Green timber generally contains about 100 per cent. moisture, based on the oven-dry weight.

Seasoning.

The drying characteristics are much the same as those for *E. regnans* (7). The rate of drying, however, is somewhat slower, and the more refractory material is more difficult to dry without degrade. Collapse

* See Foreword.

occurs commonly although not as severely as in the case of *E. regnans*, but recovery under a reconditioning treatment is usually good. As far as can be judged from information at present available, back-sawn timber of this species requires a somewhat milder schedule than that recommended for *E. regnans*, and a slightly longer drying time is necessary (13). On the other hand, quarter-sawn material can be dried by the same schedule as recommended for *E. regnans*. If dense stock is being dried, watch should be kept for signs of checking. Quarter-sawing and partial air-drying prior to kiln-drying are recommended for most satisfactory results.

Durability and Adaptability to Preservative Treatment.

This timber is considered to be somewhat more resistant than *E. regnans* or *E. gigantea*, and is used in Tasmania for poles and piling. It is a difficult timber to treat with either water soluble or oil preservatives, even under pressure (13).

Uses.

Main Uses.	Secondary Uses.	Possible Uses.
General building construction (Victoria). Flooring, Motor bodies, Furniture and cabinet work, Wharf construction, General building construction — Tasmania.	Posts and poles. Wheel spokes. Fencing. Railway construction — flooring on trucks, general use. Mining timbers. Piles. Railway sleepers. Palings. Coffin boards. Case timber.	Tight cooperage — wine casks. Wood wool. Paper pulp—chemical.

Chemical Composition.

The following results for 20 different samples have recently been published (6)—these results are based on the oven-dry weight of the wood.

Constituent.	Average.	Range.
	%	%
Cellulose (Cross and Bevan)	47	37–54
Lignin, according to standard methods adopted by the Division of Forest Products	21	18–25
Material soluble in N/8 sodium hydroxide solution ..	27	20–41
Hot water soluble material	14	8–27
Ash	Approximately 0.1	..

Sulphite pulp from this timber has been successfully used in the experimental production of newsprint (5). Good groundwood pulp has also been obtained from young trees; but it is inferior to that from *E. regnans* (4).

Wood Structure.

Macroscopic and microscopic examination of 33 different samples gave the following results:—

Burning splinter test.—Match size splinters burn to a charcoal with, in some cases, a few flecks of ash.

Pores.—Large to medium in size, mostly single, but appearing under lens in the arrangement of short oblique chains, crowded in the early wood, and numbering from 70 to 150 (average 105) per area of 20 sq. mm.

Vessel lines.—Conspicuous on longitudinal faces.

Vessel contents.—Tyloses numerous, and extraneous materials present to some extent.

Rays.—Scarcely visible on cross section except with lens; readily visible on radial faces.

Minute anatomy.—*Rays,* heterogeneous, varying in size in the different samples (size of cell also varying); numbering from 50 to 90 per sq. mm., average 65; frequently biseriate—5 to 30 per cent., but generally more than 15 per cent.; sometimes triseriate—up to 6 per cent. in 25 per cent. of samples examined; maximum number of cells high—13 to 21, average 6 to 9; generally less than 40 per cent. of cells containing extraneous material; *parenchyma.* not abundant, paratracheal with a little diffuse in some samples; black deposits sometimes found in lumina of fibres.

Remarks.—There is considerable variation in the structure of the wood of this species and this appears to be independent of locality. Samples from the same locality are often widely different in general microscopic appearance.

E. obliqua can generally be distinguished from *E. regnans* by its greater weight and from *E. gigantea* by the greater number of biseriate rays and the presence of triseriate rays.

Illustrations.—See Plates 5 and 6.

3. General Discussion of *E. regnans, E. gigantea* and *E. obliqua.*

Timber.—The trees of these three species are characterized by a long, straight bole with slight taper. Butt diameters of 8 feet and more and clear boles of 100 feet and more are not uncommon. These species are therefore eminently suitable for the production of long lengths of straight-grained timber, but since the major outlet is for floorings, linings, &c., and furniture timber, the majority of the mills are designed to cut only short length logs (up to 25 or 30 feet), and the most common length produced is about 16 feet. Longer lengths can be obtained for structural purposes if special arrangements are made, but this is not usually favoured except in the case of *E. obliqua.* A common size of log milled is about 2 ft. 6 in., to 3 feet in diameter.

Sapwood and Truewood.—The width of the sapwood in these species is very small compared with the diameter of the tree, and while it is distinct in the log, being lighter in colour than the truewood, it is often difficult to detect in converted timber when sap stains make it as dark and, in some cases, darker than the truewood. Since the sapwood is readily attacked by the powder post borers (Lyctidae) (13), it is rigidly excluded in milling, particularly in timber for higher grade uses. Occasionally a small amount of wane and sapwood is encountered in structural sizes, and if this is attacked by *Lyctus* it need cause no alarm, for the attack is confined to the sapwood, which is a small percentage of the piece. There is no record of the truewood having been attacked by furniture borers (Anobidae), and for this reason these timbers are particularly suited for use in places where borer infestation is likely to be serious. In Australia, they are commonly used for the replacement of softwoods attacked by *Anobium*.

Heart.—The central portion of the bole ultimately becomes the so-called "heart" of the mature tree, and is often unsuitable for use due to low strength and the presence of compression failures (transverse shakes) and decay. This "heart" timber also tends to collapse very seriously during seasoning. "Heart" is excluded in the milling of all timber where strength is a factor, such as building scantling and flooring boards, but recent investigations have shown that, where free from compression failures and decay, and where properly seasoned and reconditioned to remove collapse, this material is eminently suited for some classes of joinery, furniture, and similar products. Further, since in the early years of life these species are very rapid in growth and produce low density wood with comparatively wide growth rings, much of this material has the advantage of lighter weight and greater ease of working.

Selection.—Preliminary investigations have shown that, for purposes requiring high shock resistance, selection according to position in the tree is desirable (13). It is not possible at present to give general rules for selection of material for such purposes, but it seems preferable to avoid butt material and that approaching the pith of the tree.

Faults.—Until recent years, the main disability attendant upon the use of these timbers was the severe collapse which occurred during drying. Collapse is an abnormal shrinkage which occurs during the early stages of drying, and is due to a flattening of the individual cells of the timber, so that the lumina often almost disappear. Apart from inferior working qualities and the increased density of collapsed wood, the fault commonly necessitated the cutting of timber as much as 25 to 30 per cent. oversize. About 1920, Messrs. Grant Bros. of Warburton, Victoria, discovered that when seasoned timber which had collapsed was subjected to a steaming treatment for several hours at about 212°F., it reverted to its original shape and the collapse was removed. The total shrinkage from the green state of such reconditioned timber was then no greater than is usual in timbers of similar density. This process is now a standard feature of the seasoning practice with these timbers, and kiln-dried and reconditioned timber is readily available.

Although the very rapid height growth of the young tree and its clean bole results in an almost entire absence of knots in the timber as milled, these species have other types of defects which are of common occurrence. These are the gum veins which are produced by injuries to the cambium layer, and which appear in the log as concentric sheaths varying widely in their length and in the portion of the growth ring affected, depending on the extent of the original injury. In back-sawn timber, they appear as splashes of dark-coloured gummy deposits, while on the radial face they show as dark lines which vary widely in thickness. Very thin gum veins are sometimes called gum threads. Although the defect is referred to as gum, it is really a kino, and must not be confused with the resin of softwoods. In the seasoned timber, therefore, gum veins do not "bleed," so that gum vein timber when covered with paint is equally as good as clear grades. The incidence of gum veins varies widely according to the districts in which the timber was grown. Generally, the Tasmanian forests contain a greater proportion of gum free timber, so that the percentage of clear grades produced is higher. This is particularly the case in *E. obliqua,* for in Victoria the quantity of gum free timber available is so small that this species is used for structural purposes rather than for purposes in which appearance is the major factor.

Pin holes are another defect occasionally encountered, but owing to misapprehension the importance of these has been greatly over-stressed. The pin hole borers work in the living or freshly felled tree, and no borers remain alive in the seasoned timber nor does re-infestation take place. The presence of the borer holes, however, has often been taken in the past as an indication of powder post and furniture borers. This is, of course, entirely erroneous, and the difference in the holes can be readily detected because those of the pin hole borer are generally free from frass which, if present, is stringy in texture, and the holes often slightly discoloured, whereas those of the powder post and furniture borers contain frass of a floury or gritty texture and dark discolourations are not present. In addition, eucalypts are not subject to attack by furniture borers.

Grading.—Standard grading rules for flooring, linings, and weatherboards applicable to all States have been prepared by Committees of the Standards Association of Australia. Later, the grading of joinery, furniture stock, and other products will be considered.

Originally, in products such as flooring, it was usual to specify clear material for all purposes. Now, however, it is realized that in the majority of high grade polished floors gum threads are not deleterious, while excellent flooring to be stained or covered by linoleum can be manufactured from timber carrying a high percentage of gum. It is now realized that the most important factor in a floor is proper seasoning, and quarter-sawn kiln-dried and reconditioned floorings, both in clear grades and in those containing gum, are giving excellent service.

Strength Properties.—While a considerable number of tests have been carried out on the mechanical properties of these timbers, the test methods have not been according to the standard procedure now adopted internationally; in addition they are very incomplete.

For these reasons, and since the ultimate requirements in design are working stresses rather than ultimate breaking loads, the actual test

results have not been recorded here, but the following table has been prepared:—

Type of Stress.	Working Stress.
Bending	2,000 lb. per square inch
Struts—	
Where $\frac{L}{D}$* is less than 10	1,200 lb. per square inch
Where $\frac{L}{D}$ is from 10 to 25	1,400—20 $\frac{L}{D}$ lb. per. square inch
Bearing—across grain	450 lb. per square inch
Shearing—	
Horizontal shear in beams	170 lb. per square inch
Shear in joint details	250 lb. per square inch
Modulus of elasticity	2,000,000 lb. per square inch

* *L = length ; D = least dimension.*

These figures are applicable to ordinary structural material of good merchantable quality such as is normally used in building construction. For high quality seasoned material, free from major defects, such as is used for flooring, the working stresses may be increased 25 per cent. or even more for good locations. It will be noticed that in grouping the three species together, no account has been taken of the somewhat higher strength value to be expected from the heavier *E. obliqua.* Where dense material of this species is concerned, a further increase in working stresses would be allowable. It must be realized, of course, that these figures, while they are considered safe, are subject to revision when the results of further projected mechanical tests are available. These, when correlated with structural grading rules, will give increased working stresses in the higher grades.

Of the three species, *E. gigantea* is usually favoured for purposes where shock resistance is a factor. This is shown by its use for boat oars, skis, &c., and the preference for it in handles and similar stock of the better grades.

4 Description of the Remaining Species.

Eucalyptus sieberiana F.v.M.

Trade and Vernacular Names.

Recommended.—Silver-top.

Commonly used.—Mountain ash (Vic. and N.S.W.), ironbark (Tas., Vic.), coast ash (N.S.W.), black ash (N.S.W.).

Rarely used.—White-top ironbark (Tas.), Blue Mountain mountain ash (N.S.W.).

Habit and Distribution (1, 2, 3, 8, 10, 12).

The tree is tall, attaining some 150 feet in height, and possesses a rough, compact, deeply furrowed, dark, flaky bark by means of which it

may be readily recognized in the field. This type of bark has given rise to the name "ironbark," owing to its resemblance to the bark of the true ironbarks.

It occurs in the central coastal, central tableland, and south coast districts of New South Wales; in Victoria it is abundant in many parts of the eastern coast districts and central Gippsland on the eastern mountains up to 3,500 feet, and also in the Cape Otway Peninsula; in Tasmania it is confined chiefly to the northern portion of the east coast.

*Supplies.**

Estimates as to supplies of this timber are incomplete. In Victoria the estimated standing volume for nine major milling districts is 730,000,000 super feet in the round. During the past five years, the average annual cut has been approximately 2,000,000 super feet in the round. In Tasmania, there is approximately 100,000,000 super feet available, but the timber is not being milled, and very little is being cut for any purpose.

General Characteristics of the Wood.

The timber is usually of a brown colour, although it is sometimes pinkish. Gum veins are commonly present. It is moderately heavy, being heavier than either *E. regnans* or *E. gigantea* and of a closer texture than these timbers. The grain is often interlocked. Growth rings are discernible but not prominent. Sapwood is generally up to 1 inch in width, and not very distinct in seasoned timber.

Weight.

The weight when seasoned to 12 to 15 per cent. moisture content varies from 50 to 60 lb. per cubic foot, and when green from 67 to 77 lb. per cubic foot. The basic density range as determined for 24 samples is 38 to 47 lb. per cubic foot, average 42 lb. per cubic foot.

Moisture Content.

Available figures show the moisture content of the green wood to be approximately 65 to 70 per cent. based on the oven-dry weight.

Seasoning (13).

It is a more difficult timber to season without degrade than either *E. regnans* or *E. obliqua*, and the rate of drying under similar conditions is decidedly slower. The main form of degrade to guard against is surface checking. Collapse is not common. Quarter-sawing and partial air-drying before kiln drying are essential for the best results. It is possible to kiln-dry 1″ quarter-sawn stock which has been partially air-dried (30 per cent. moisture content) under the same schedule as is used for partially air-dried *E. regnans*.

Durability and Adaptability to Preservative Treatment.

While not recognized as a durable timber, it is more durable in contact with the ground than *E. regnans* or *E. gigantea*, and has been used for fence posts. Sapwood is attacked by the powder post borers.

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* See Foreword.

It is a very difficult timber to treat successfully with preservatives even under pressure (13).

Uses.

Main Uses.	Secondary Uses.
General building construction. Vehicle construction— Poles. Shafts. Wagon construction—beams.	Furniture. Flooring. Handles— Axe. Pick. Packing cases. Fencing— Posts. Rails. Palings. Railway trucks—flooring and diagonals.

Chemical Composition.

Results of the chemical examination of ten different samples have been published (6). In this work, the following average figures were obtained:—

Constituent.	Average.	Range.
	%	%
Cellulose (Cross and Bevan)	50	45–50
Lignin, determined according to standard methods adopted by the Division of Forest Products ..	20	19–21
Material soluble in N/8 sodium hydroxide solution ..	24	17–30
Hot water soluble material	9	3–16
Ash	Approximately 0.1	..

This timber has been found satisfactory for chemical pulping (4). It is somewhat dense, however, for the preparation of groundwood pulp.

Wood Structure.

Macroscopic and microscopic examination of 12 samples gave the following results:—

Burning splinter test.—Match size splinters burn to a charcoal with—in some cases—a small amount of ash.

Pores.—Medium to small in size, single; fairly numerous ranging from 140 to 230 per area of 20 sq. mm. (average 170), in this respect being smaller and more numerous than in *E. regnans*, *E. gigantea*, and *E. obliqua*.

Vessel lines.—Fine, but conspicuous on longitudinal faces.

Vessel contents.—Tyloses fairly numerous; some extraneous materials present.

Rays.—Very fine, not visible on cross sections without lens; distinct narrow ray bars, visible on quarter-cut surfaces.

Minute Anatomy.—*Rays,* heterogeneous, numbering from 50 to 85 per sq. mm., average 65; mainly uniseriate, very few biseriate, but up to 15 per cent. in one case; maximum number of cells high—13 to 20, average number 6 to 8; 40 to 100 per cent. of cells filled with extraneous materials; *parenchyma,* not abundant, paratracheal with some diffuse; black deposits common in parenchyma cells and in the lumina of fibres.

Remarks.—This timber is denser and of a closer texture than *E. regnans* and *E. gigantea.* It differs from that of *E. obliqua* in possessing smaller and more numerous pores.

Illustrations.—See Plates 7 and 8.

Eucalyptus fastigata Deane and Maiden.

Trade and Vernacular Names.

Recommended.—Cut-tail.

Others.—Brown-barrel, blackbutt, black mountain ash, silver or white-top woollybutt.

Habit and Distribution—(1, 3, 8, 12).

A large tree, commonly 120 feet high and 36 inches in diameter, with a clear bole of 50 to 60 feet, with a fibrous bark extending up the trunk to the secondary limbs, and with smooth bark on the upper branches. It occurs in the central and southern parts of the main dividing range in New South Wales, and extends into Victoria in the higher parts of East Gippsland on the southern side of the eastern mountains.

Supplies.

Recorded as plentiful on the southern tablelands and slopes in New South Wales.

General Characteristics of the Wood.

The timber is very pale brown in colour, straight grained, and of open texture. It is moderately light in weight, being slightly heavier than *E. regnans.* Growth rings are not prominent; and the sapwood is not readily distinguishable in seasoned timber.

Weight.

Air-dry, 41 to 50 lb. per cubic foot; green, 63 to 75 lb. per cubic foot; basic density, 33 to 39 lb. per cubic foot.

Seasoning.

The general behaviour in seasoning is probably similar to *E. regnans.*

Durability.

Not durable in contact with the ground; sapwood attacked by powder post borers.

Uses.

General building construction; flooring.

Wood Structure.

Macroscopic and microscopic examination of twelve samples gave the following results:—

Burning Splinter Test.—Match-size splinters burn to a charcoal with no ash, or, in some cases, a few flecks of ash.

Pores.—Large to medium in size, single, although often appearing under lens in apparent oblique chains, numbering from 100 to 164 per area of 20 sq. mm.

Vessel Lines.—Conspicuous on longitudinal faces.

Vessel Contents.—Tyloses present.

Rays.—Visible on quarter cut surfaces, but difficult to distinguish on cross section without lens.

Minute Anatomy.—*Rays*, heterogeneous, long and narrow; majority uniseriate, a few—up to 12 per cent.—biseriate; numbering 50 to 70 per sq. mm. of tangential surface; maximum number of cells high—17 to 35; average, 7 to 11; 3 to 35 per cent. of rays are more than 15 cells high; cells contain little extraneous material; *parenchyma*, not abundant, paratracheal.

Illustrations.—See Plates 9 and 10.

Eucalyptus consideniana J.H.M.

Trade and Vernacular Names.

Recommended.—Yertchuk.

Others.—Messmate, peppermint.

Habit and Distribution—(1, 3, 8).

A medium-sized tree with grey tough bark of a sub-fibrous nature extending to the tips of the branches—it resembles a fine yellow-barked messmate. It occurs on the central and coastal ranges and slopes in New South Wales, and in Gippsland, Victoria, but is not plentiful.

General Characteristics of Wood.

The timber is light brown in colour, of open texture, and gum veins are sometimes present. It is sometimes interlocked and is in general denser than other members of this group with the exception of *E. sieberiana.*

Weight.

Air-dry, 58 lb. per cubic foot; green, 73 to 80 lb. per cubic foot; basic density range from 40 to 55 lb. per cubic foot; average, 46 lb. per cubic foot, one sample only giving basic density above 50 lb. per cubic foot.

Uses.

No definite uses are known, but the timber should be suitable for general building, flooring, and fencing.

Wood Structure.

Macroscopic and microscopic examination of 10 samples gave the following results:—

Burning splinter test.—Match size splinters burn to a charcoal.

Pores.—Medium in size, single, and numbering from 100 to 200 per area of 20 sq. mm.

Vessel lines.—Fairly conspicuous.

Vessel contents.—Tyloses present as well as some extraneous material.

Parenchyma.—Apparent, under lens, surrounding pores.

Rays.—Visible on cross section under lens, readily distinguishable on radial surfaces.

Minute Anatomy.—*Rays,* heterogeneous, short and narrow, numbering from 50 to 73 per sq. mm. of tangential surface; majority uniseriate, but some biseriate—up to 25 per cent. in some samples, in one case a few triseriate; maximum number of cells high—from 10 to 18, but generally less than 15; average number of cells high—6 to 7; 20 to 70 per cent. of cells containing extraneous material; *parenchyma,* abundant to not abundant, paratracheal but some diffuse in a few samples.

Eucalyptus oreades R.T.B. syn. ***E. altior*** Deane and Maiden.

Vernacular Names.

Recommended.—Smooth barked ash.

Others.—Mountain ash.

Habit and Distribution (3, 8, 12).

A tall, clean tree, with a smooth whitish bark from the ground, or sometimes having a lighter rough bark for the first 8 feet. It is found at moderately high elevations on the main dividing range and spurs from central New South Wales to southern Queensland, and is fairly plentiful in patches through the Blue Mountains, New South Wales.

General Characteristics of the Wood.

The timber is pale in colour, rather soft and fissile; with open texture and straight grain. Gum veins are sometimes present. There is no very clear distinction between sapwood and truewood. Growth rings are fairly well defined owing to greater concentration of pores in the early wood. The timber is not durable in contact with the ground.

Weight.

Air-dry, 41 to 46 lb. per cubic foot; green, 60 lb. per cubic foot; basic density for 3 samples only, 32 to 34 lb. per cubic foot.

Uses.

This timber is not often milled, but it has been used for the following purposes:—

Joinery, cabinet work, manufacture of pegs, and general building.

Wood Structure—macroscopic and microscopic (3 samples).

Burning splinter test.—Match sized splinters burn to a charcoal with a very fine grey ash.

Pores.—Medium in size, single and tending to be concentrated in early wood.

Vessel lines.—Distinct on longitudinal surfaces.

Vessel contents.—Some tyloses present, but they are not common.

Rays.—Scarcely visible without lens on cross section, distinct on radial surfaces.

Minute Anatomy.—*Rays,* heterogeneous, mainly uniseriate, and up to 20 cells high, cells containing very little extraneous material; *parenchyma,* not abundant, paratracheal.

Eucalyptus fraxinoides Deane and Maiden.

Vernacular Names.

Recommended.—White ash.

Others.—White mountain ash.

Habit and Distribution (3, 8, 12).

A tall slender tree up to 120 feet in height and 3 to 4 feet in diameter breast high; bark rough half way up the trunk and with the outer layer of the upper portion sometimes falling off in ribbons. It occurs at moderately high elevations in the southern tablelands of New South Wales.

General Characteristics of Wood.

The timber is pale brown in colour, free working, of moderately open texture, and generally straight grained, although sometimes interlocked. Some gum veins are present; growth rings are not always prominent; the wood is not durable in contact with the ground.

Weight.

Air-dry, 41 to 45 lb. per cubic foot; green, 65 to 75 lb. per cubic foot; basic density, 36 to 38 lb. per cubic foot.

Uses.

General building, cabinet work, flooring, and fruit cases.

It has been tried for aeroplane construction and considered suitable.

Wood Structure—macroscopic and microscopic (3 samples).

Burning splinter test.—Match size splinters burn to a charcoal.

Pores.—Medium to small in size, single, numbering from 100 to 175 per area of 20 sq. mm.

Vessel lines.—Fine but conspicuous.

Vessel contents.—Tyloses present, and some extraneous material.

Rays.—Not visible on cross section except with lens, easily distinguishable on radial sections.

Minute Anatomy.—*Rays*, heterogeneous, up to 22 cells high, majority uniseriate, a few biseriate; cells containing some extraneous material, *parenchyma*, not abundant and mostly paratracheal.

Separation Key.

While the positive identification of these timbers is always difficult, a key for the separation of *E. regnans*, *E. gigantea*, *E. obliqua*, *E. sieberiana*, *E. fastigata*, and *E. consideniana* is given on page 28. This key is based on both macroscopic and microscopic features.

6. References to Literature.

The following references were consulted during the preparation of these notes:—

1. R. H. Anderson—"The Trees of New South Wales." New South Wales Department of Agriculture, Government Printer, Sydney, 1932.
2. Australia: Collected Statements of the Forest Authorities. Third British Empire Forestry Conference, Australia and New Zealand. 1928.
3. R. T. Baker—"The Hardwoods of Australia and their Economics." Department of Education, New South Wales, Technical Education Series No. 3. 1919.
4. L. R. Benjamin—"Newsprint. Preliminary Experiments on the Grinding of Immature Eucalypts for Mechanical Pulp and Possibilities of Manufacturing Newsprint in Australia." Council for Scientific and Industrial Research, Australia, Bulletin 31, 1927.
5. L. R. Benjamin and J. L. Somerville—"Paper Pulp and Cellulose from the Eucalypts by the Sulphite Process." Council for Scientific and Industrial Research, Australia, Bulletin 37, 1928.
6. W. E. Cohen, A. G. Charles, and A. B. Jamieson—"The Chemistry of Australian Timbers, Part 3—Chemical Composition of 4 Pale Coloured Woods of the genus *Eucalyptus*:—*E. gigantea*, *E. obliqua*, *E. regnans*, and *E. sieberiana*." (Division of Forest Products Technical Paper No. 9.) Council for Scientific and Industrial Research, Australia, Pamphlet 44, 1933.
7. C. Sibley Elliot—"A Guide to the Seasoning of Australian Timbers—Part 1." (Division of Forest Products, Technical Paper No. 7.) Council for Scientific and Industrial Research. 1933, Australia, Pamphlet 40.
8. J. H. Maiden—"A Critical Revision of the Genus *Eucalyptus*." Government Printer, Sydney, 1924.
9. R. T. Patton—*Proc. Roy. Soc. Vic.*, 30: 1. 1917.
10. C. C. Robertson—"A Reconnaissance of the Forest Trees of Australia," Forest Department, Union of South Africa, 1926.
11. R. S. Troup—"Exotic Forest Trees in the British Empire," Clarendon Press, Oxford, 1932.
12. M. B. Welch—"The Wood Structure of Certain Eucalypts belonging chiefly to the Ash Group. *J. and Proc. Roy. Soc., N.S.W.*, 60: 147, 1926.
13. Unpublished work of the various sections of the Division of Forest Products.

SEPARATION KEY.

E. gigantea, *E. regnans*, *E. obliqua*, *E. fastigata*, *E. consideniana*, *E. sieberiana*

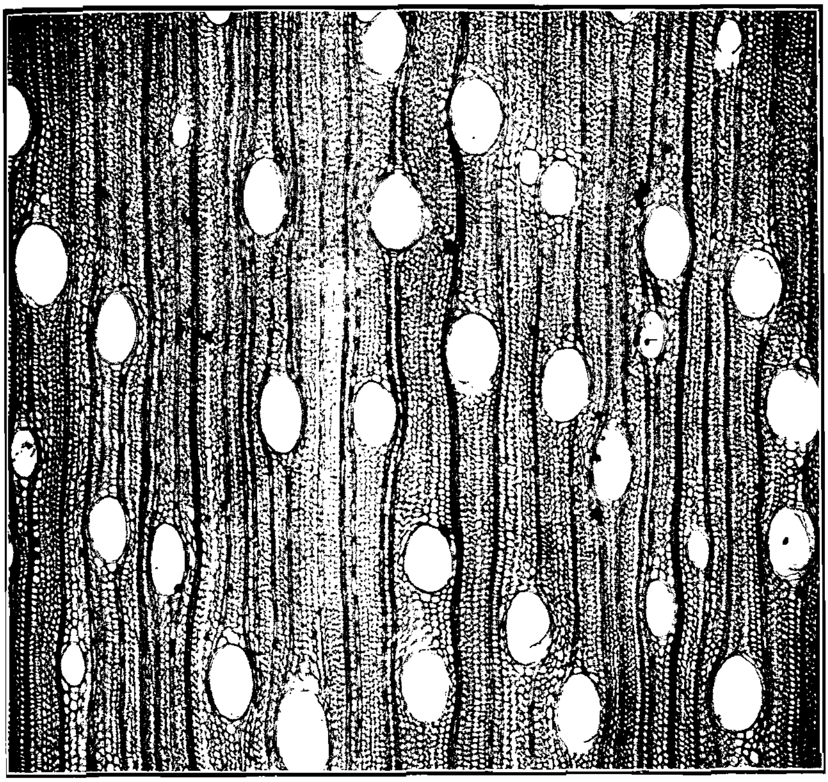
Density

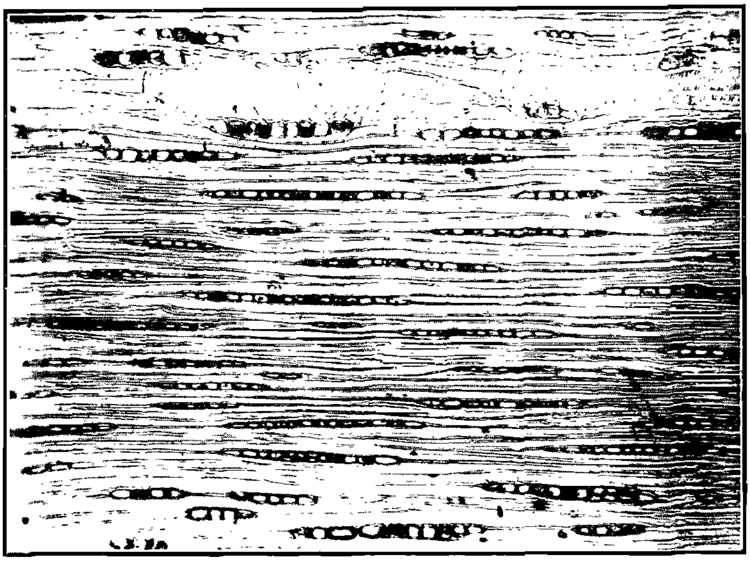
- Light to moderately light in weight (Basic density below 40 lb. per cu. ft.)
  - *E. gigantea*, *E. regnans*, *E. obliqua*, *E. fastigata*, *E. sieberiana* (some samples)
  - Growth rings
    - Distinct and tendency for pores to be grouped in early wood
      - *E. gigantea*, *E. regnans*, *E. obliqua*
      - Microscopic examination of tangential section
        - Ray cells large, biseriate rays common, sometimes triseriate rays present — **E. obliqua**
        - Ray cells small, biseriate rays not common, mostly less than 10 per cent. — **E. gigantea**, **E. regnans**. *E. gigantea* shows a greater tendency to ring porosity than *E. regnans*
    - Not very distinct.
      - *E. fastigata*, *E. sieberiana*
      - Pores
        - Large and not numerous — **E. fastigata**
        - Medium to small in size and numerous — **E. sieberiana**
- Moderately heavy (Basic density above 40 lb. per cu. ft.
  - *E. consideniana*, *E. sieberiana*, *E. obliqua*
  - **Pores**
    - Large in size not numerous
      - *E. obliqua*, *E. consideniana*
      - Microscopic examination of rays
        - Ray cells large, biseriate rays common, sometimes triseriate rays present — **E. obliqua**
        - Ray cells small, biseriate rays not common — **E. consideniana**
    - Medium to small in size and more numerous — **E. sieberiana**

This separation is not always definite owing to the grading of the samples of one species into those of the other. For example, the size of pores and number of pores varies with different samples, and this feature may not always separate *E. consideniana* from *E. sieberiana*. Again, a few *E. obliqua* samples show small-celled rays which are mostly uniseriate.

PLATE 1.

E. regnans.



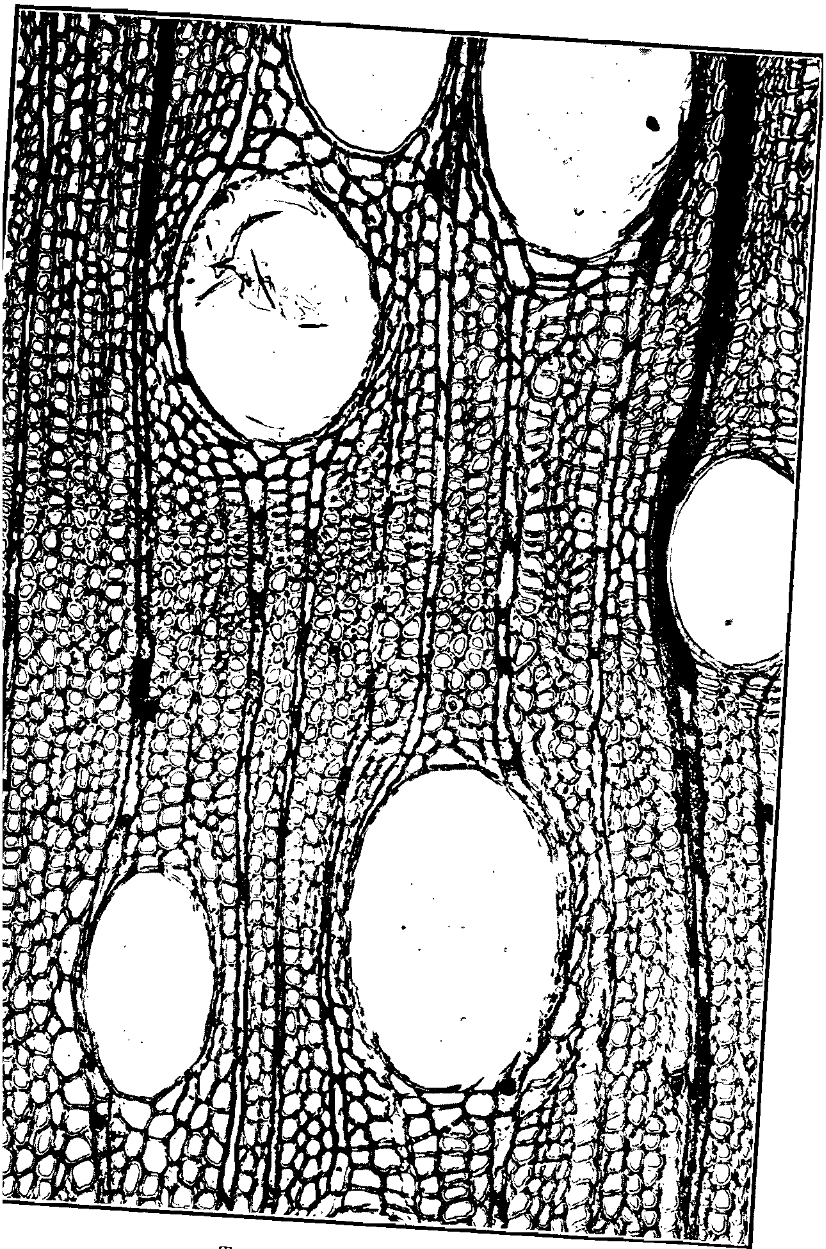


(Top)—Transverse Section × 35.

(Bottom)—Tangential Section × 95.

PLATE 2.

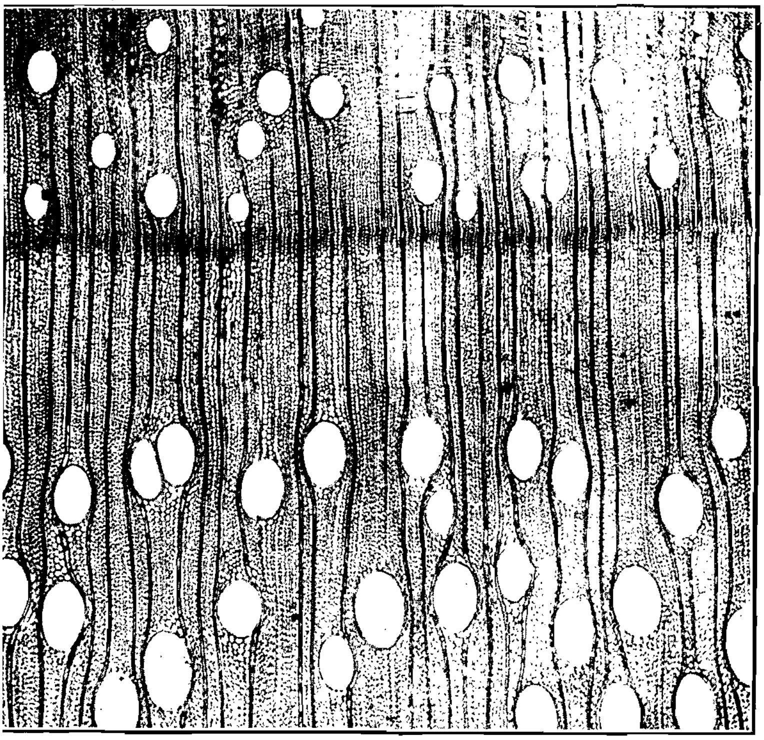
E. regnans.

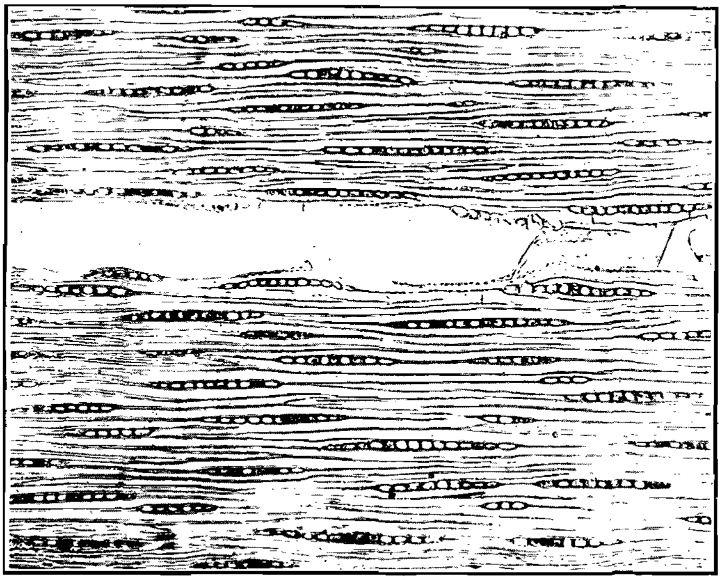


Transverse Section × 150.

PLATE 3.

E. gigantea.



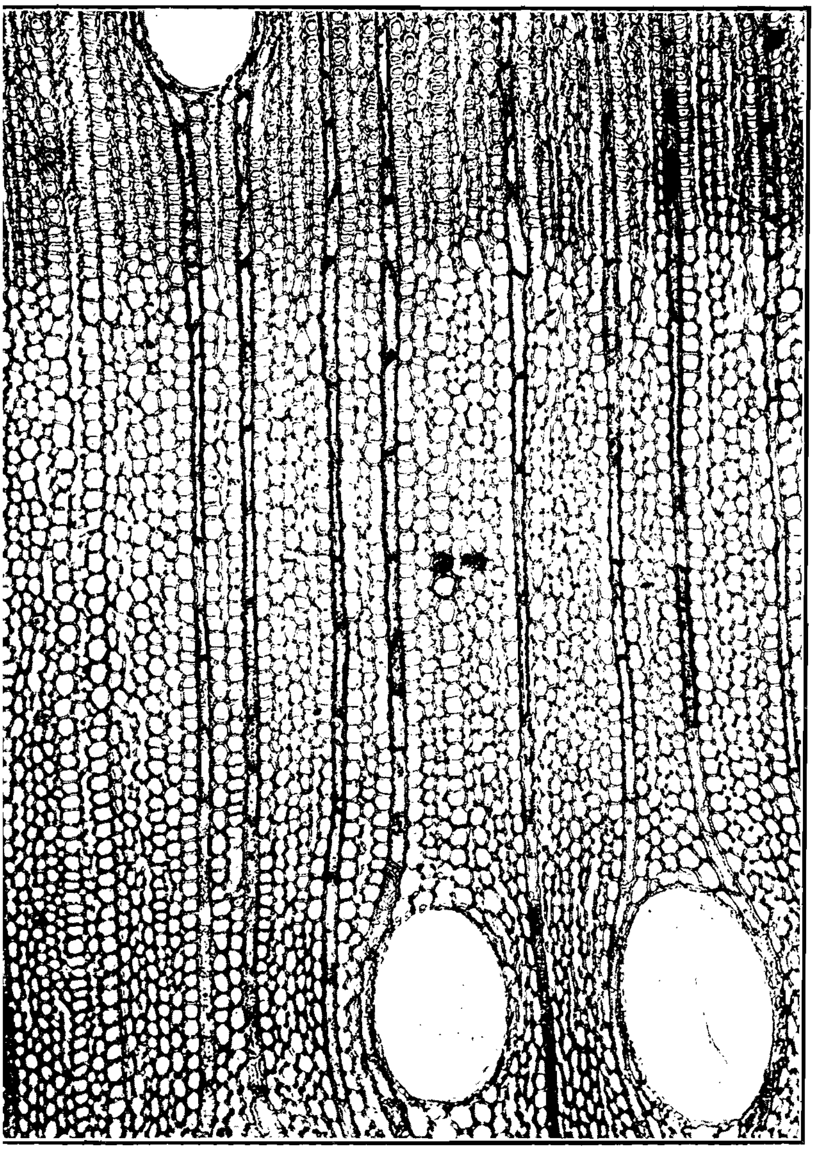


(Top)—Transverse Section × 35.

(Bottom)—Tangential Section × 95.

PLATE 4.

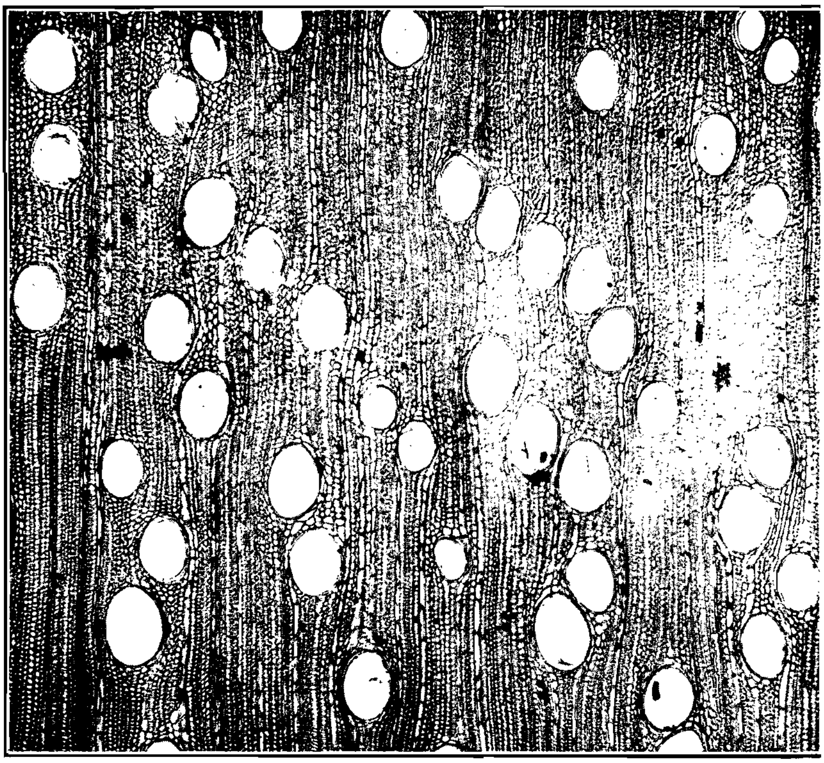
E. gigantea.

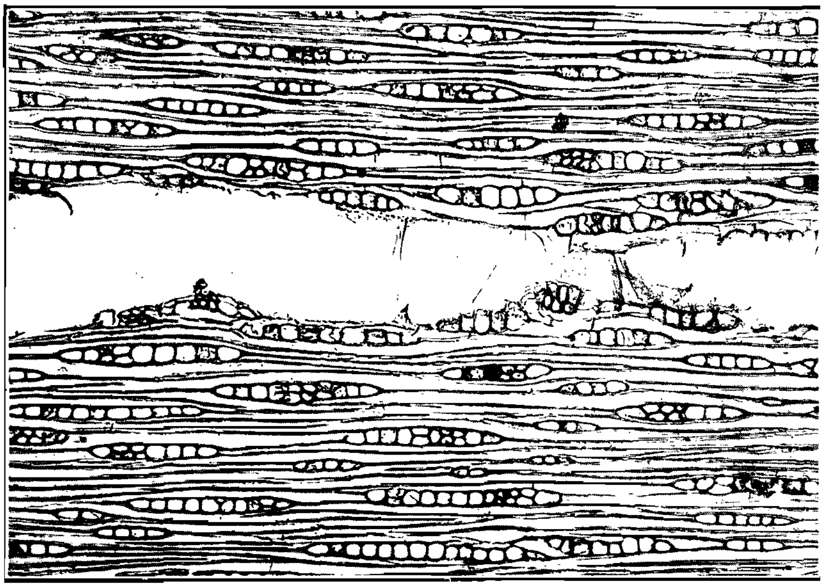


Transverse Section × 150.

PLATE 5.

E. obliqua.



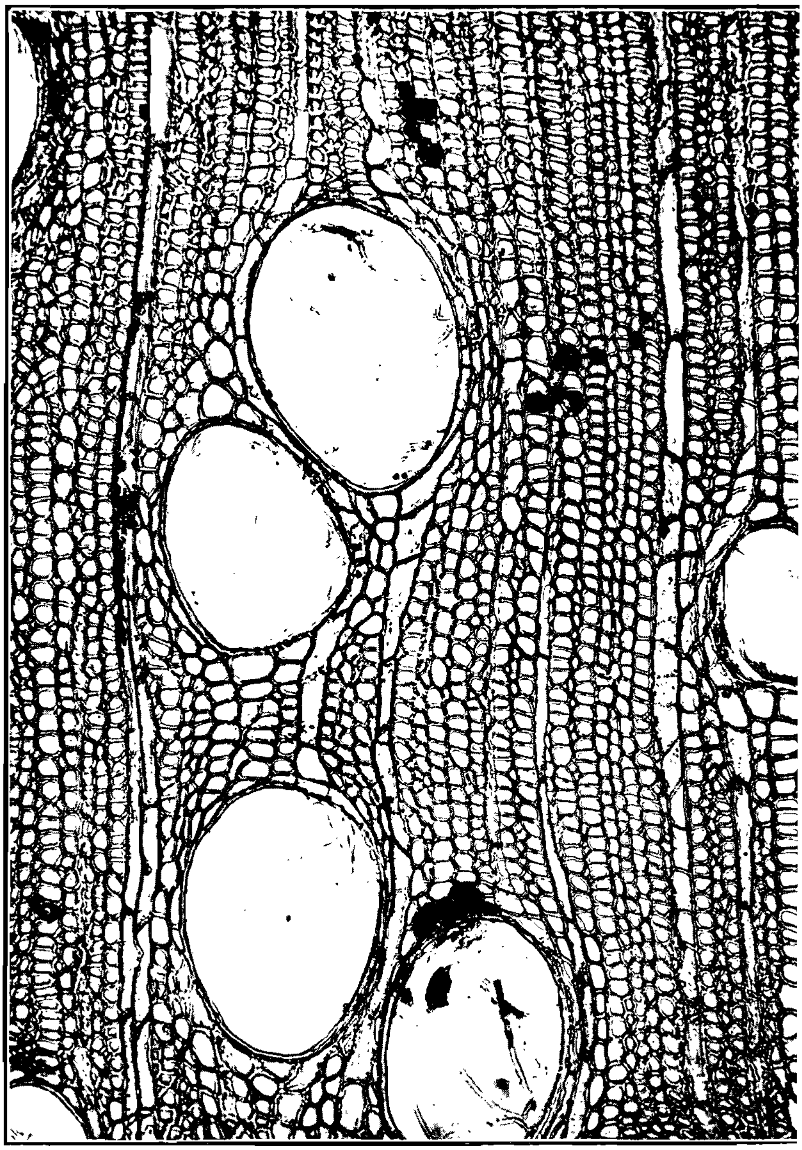


(Top)—Transverse Section × 35.

(Bottom)—Tangential Section × 95.

PLATE 6.

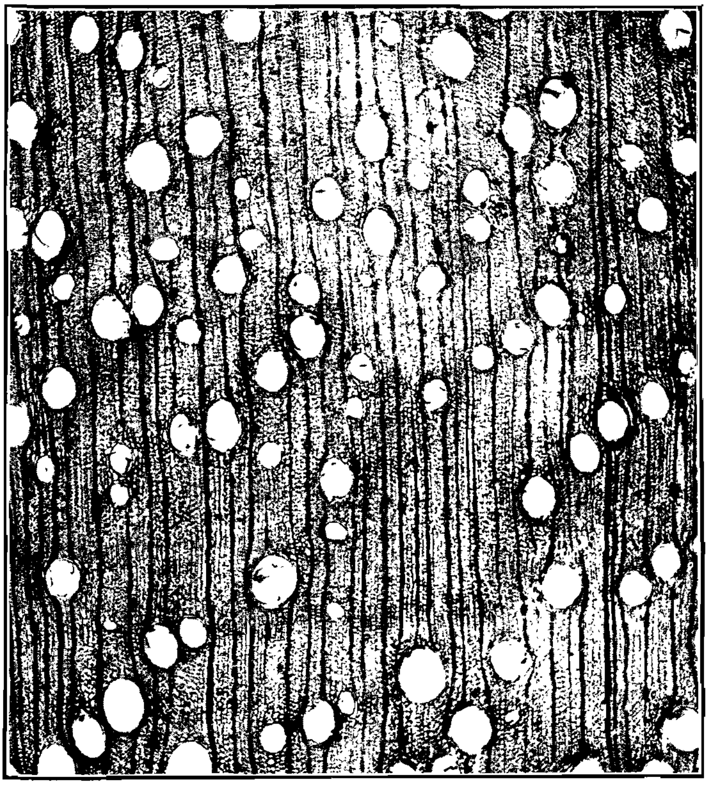
E. obliqua.

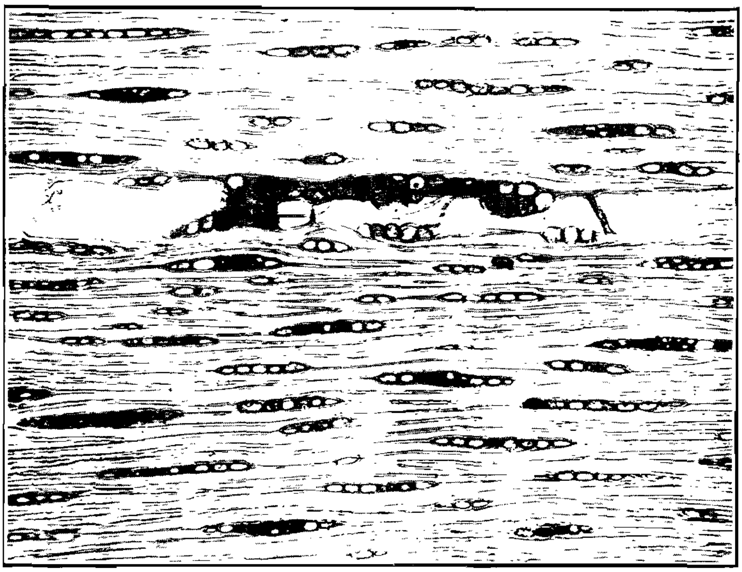


Transverse Section × 150.

PLATE 7.

E. sieberiana.

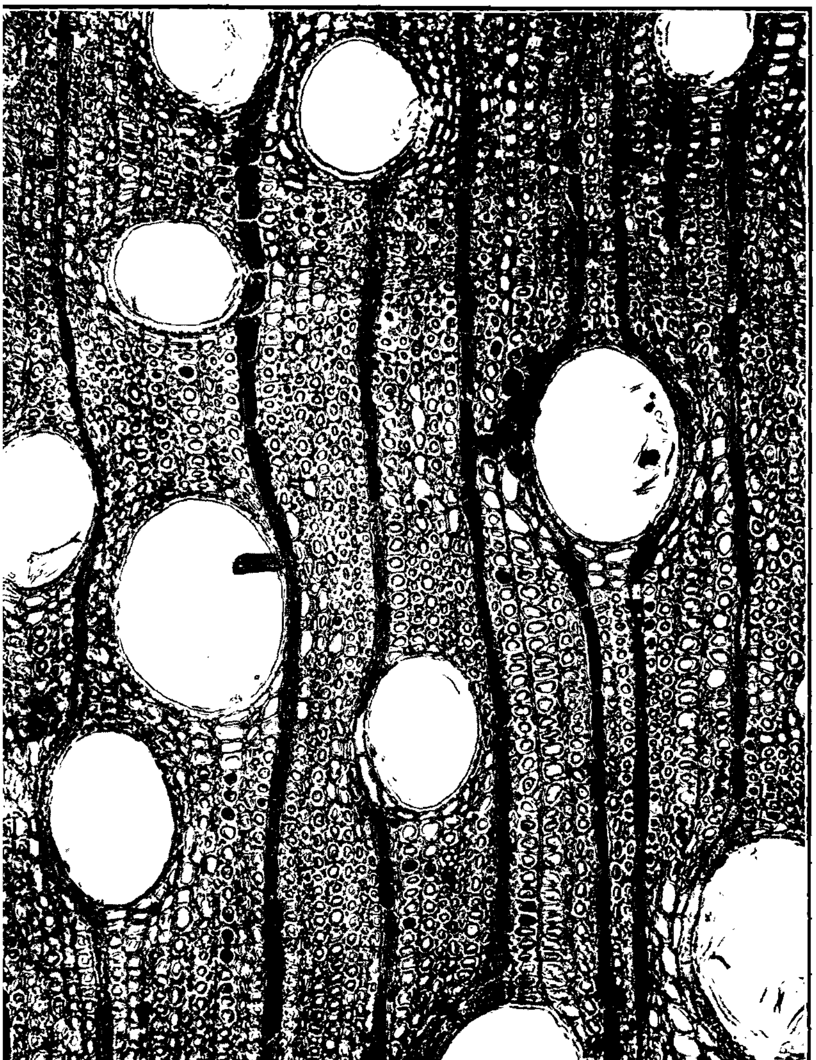




(Top)—Transverse Section × 35.
(Bottom)—Tangential Section × 95.

PLATE 8.

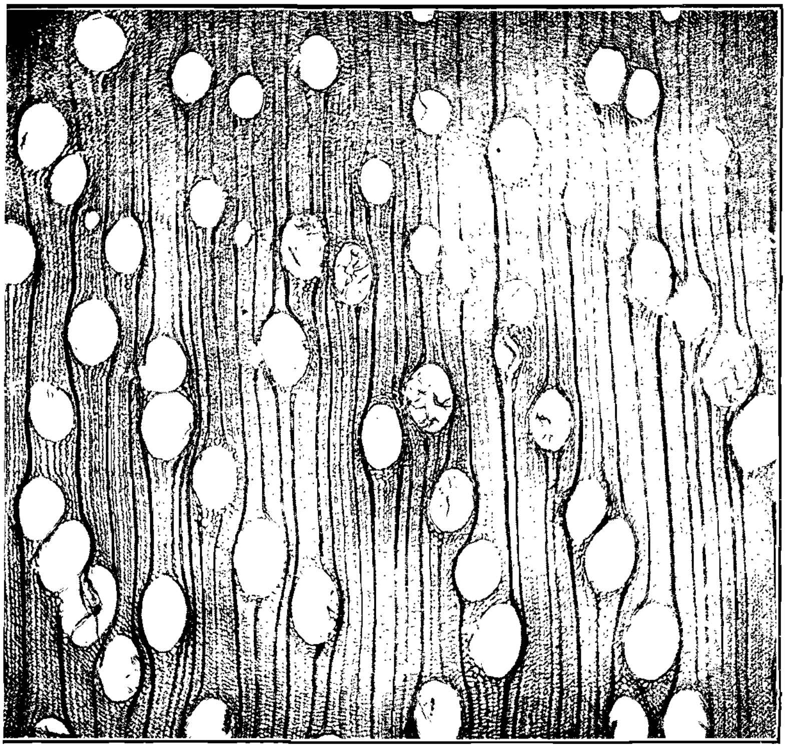
E. sieberiana.

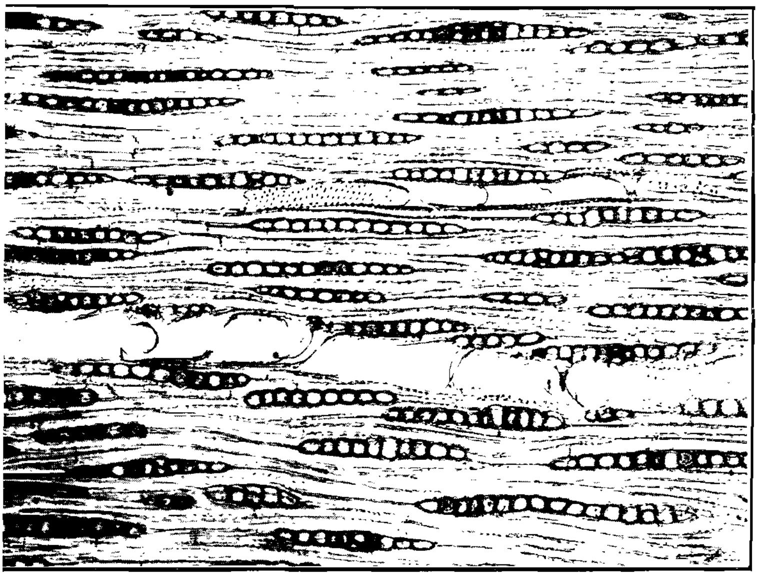


Transverse Section × 150.

PLATE 9.

E. fastigata.



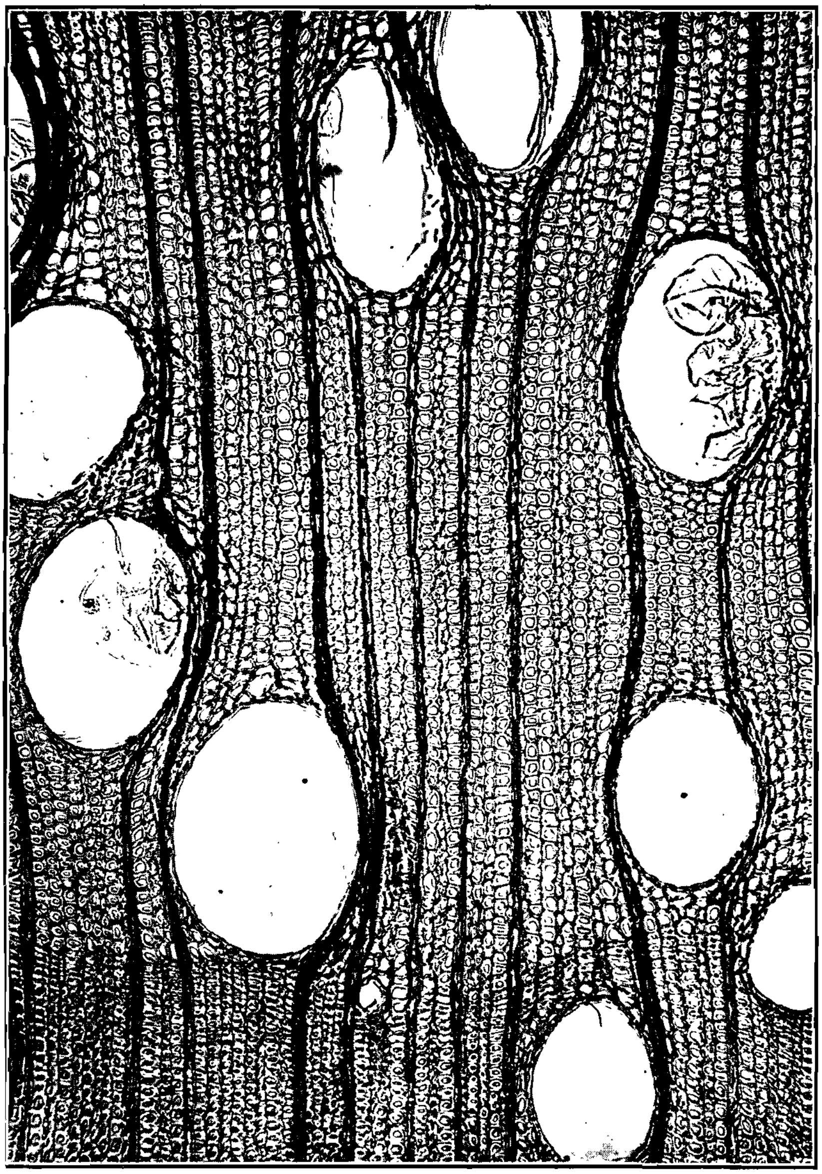


(Top)—Transverse Section × 35.

(Bottom)—Tangential Section × 95.

PLATE 10.

E. fastigata.



Transverse Section × 150.